

THAT WHICH IS CLAIMED IS:

1. A method of rapidly and accurately identifying live eggs within a stream of eggs, comprising:

candling each egg in the stream;
5 designating each candled egg as either live, non-live, or uncertain as to whether live;
 removing eggs designated as non-live and uncertain from the stream;
 recandling each egg designated as uncertain;
10 and
 returning recandled eggs determined to be live to the stream.

2. The method of Claim 1, wherein candling
15 each egg comprises measuring the opacity of each egg.

3. The method of Claim 2, wherein measuring the opacity of each egg comprises:

illuminating each egg with light from a light
20 source; and
 receiving light passing through each egg at a detector positioned adjacent the egg.

4. The method of Claim 2, wherein an egg is
25 designated as live if measured opacity is less than a first threshold value, wherein an egg is designated as non-live if measured opacity is greater than a second threshold value, and wherein an egg is designated as uncertain if measured opacity is between the first and
30 second threshold values.

5. The method of Claim 1, wherein candling each egg comprises measuring the temperature of each egg.

6. The method of Claim 5, wherein an egg is
5 designated as live if measured temperature is above a first threshold temperature, wherein an egg is designated as non-live if measured temperature is lower than a second threshold temperature, and wherein an egg is designated as uncertain if measured temperature is
10 between the first and second temperatures.

7. The method of Claim 1, wherein recandling comprises determining if each egg designated as uncertain has a pulse rate, and wherein returning recandled eggs
15 determined to be live to the stream comprises returning to the stream eggs determined to have a pulse rate.

8. The method of Claim 1, wherein recandling comprises hand candling each egg designated as uncertain,
20 and wherein returning recandled eggs determined to be live to the stream comprises returning to the stream eggs observed to have one or more of the following: red veins, an air cell at an end of the egg, or a dark embryonic area.
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9. The method of Claim 1, wherein recandling comprises detecting embryonic motion within each egg designated as uncertain, and wherein returning recandled eggs determined to be live to the stream comprises
30 returning to the stream eggs having embryonic motion.

10. The method of Claim 1, wherein recandling comprises:

illuminating each egg with light from a light

source, wherein the light includes light in both visible and infrared wavelengths;

receiving light passing through the egg at a detector positioned adjacent the egg;

5 determining intensity of the received light at a plurality of the visible and infrared wavelengths;

generating a spectrum that represents light intensity at selected ones of the plurality of visible and infrared wavelengths; and

10 comparing the generated spectrum with a spectrum associated with a live egg.

11. The method of Claim 10, wherein returning recandled eggs determined to be live to the stream comprises returning to the stream eggs having a spectrum that substantially matches the spectrum associated with a live egg.

12. A method of rapidly and accurately identifying live eggs within a stream of eggs, comprising:

candling each egg in the stream, comprising:

measuring the opacity of each egg; and

measuring the temperature of each egg;

25 designating each candled egg as either live, non-live, or uncertain as to whether live based upon the measured opacity and temperature of each egg;

removing eggs designated as non-live and uncertain from the stream;

30 recandling each egg designated as uncertain; and

returning recandled eggs determined to be live to the stream.

13. The method of Claim 12, wherein measuring
the opacity of each egg comprises:

illuminating each egg with light from a light
source; and

5 receiving light passing through each egg at a
detector positioned adjacent the egg.

14. The method of Claim 13, wherein an egg is
designated as live if measured opacity is less than a
10 first threshold value, wherein an egg is designated as
non-live if measured opacity is greater than a second
threshold value, and wherein an egg is designated as
uncertain if measured opacity is between the first and
second threshold values.

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15. The method of Claim 12, wherein an egg is
designated as live if measured temperature is above a
first threshold temperature, wherein an egg is designated
as non-live if measured temperature is lower than a
20 second threshold temperature, and wherein an egg is
designated as uncertain if measured temperature is
between the first and second temperatures.

16. The method of Claim 12, wherein recandling
25 comprises determining is each egg designated as uncertain
has a pulse rate, and wherein returning recandled eggs
determined to be live to the stream comprises returning
to the stream eggs determined to have a pulse rate.

30 17. The method of Claim 12, wherein recandling
comprises hand candling each egg designated as uncertain,
and wherein returning recandled eggs determined to be
live to the stream comprises returning to the stream eggs
observed to have one or more of the following: red veins,

an air cell at an end of the egg, or a dark embryonic area.

18. The method of Claim 12, wherein recandling
5 comprises detecting embryonic motion within each egg
designated as uncertain, and wherein returning recandled
eggs determined to be live to the stream comprises
returning to the stream eggs having embryonic motion.

10 19. The method of Claim 12, wherein recandling
comprises:

illuminating each egg with light from a light source, wherein the light includes light in both visible and infrared wavelengths;

15 receiving light passing through the egg at a detector positioned adjacent the egg;

determining intensity of the received light at a plurality of the visible and infrared wavelengths;

20 generating a spectrum that represents light intensity at selected ones of the plurality of visible and infrared wavelengths; and

comparing the generated spectrum with a spectrum associated with a live egg.

25 20. The method of Claim 19, wherein returning recandled eggs determined to be live to the stream comprises returning to the stream eggs having a spectrum that substantially matches the spectrum associated with a live egg.

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21. A system that rapidly and accurately identifies live eggs within a stream of eggs, comprising:
a conveyor configured to convey a stream of eggs;

a candling apparatus operably associated with the conveyor, wherein the candling apparatus is configured to candle each egg in the stream and to designate each candled egg as either live, non-live, or
5 uncertain as to whether live;

an egg removal device operably associated with the conveyor that removes from the stream candled eggs designated as non-live and uncertain;

10 a pulse rate detection apparatus that determines if each egg designated as uncertain has a pulse rate;

an egg transfer device operably associated with the conveyor that returns to the stream eggs determined to have a pulse rate.

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22. The system of Claim 21, wherein the candling apparatus comprises an apparatus configured to measure the opacity of each egg, wherein an egg is designated as live if measured opacity is less than a
20 first threshold value, wherein an egg is designated as non-live if measured opacity is greater than a second threshold value, and wherein an egg is designated as uncertain if measured opacity is between the first and second threshold values.

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23. The system of Claim 22, wherein the candling apparatus comprises:

a light source that illuminates each egg with light; and

30 a detector positioned adjacent each egg that receives light passing through each egg.

24. The system of Claim 21, wherein the candling apparatus comprises an apparatus configured to

measure the temperature of each egg, wherein an egg is designated as live if measured temperature is above a first threshold temperature, wherein an egg is designated as non-live if measured temperature is lower than a 5 second threshold temperature, and wherein an egg is designated as uncertain if measured temperature is between the first and second temperatures.

25. The system of Claim 21, wherein the pulse
10 rate detection apparatus is configured to detect
embryonic motion, and wherein the egg transfer device
returns to the stream eggs detected as having embryonic
motion.

15 26. A system that rapidly and accurately
identifies live eggs within a stream of eggs, comprising:
a conveyor configured to convey a stream of
eggs;
a candling apparatus operably associated with
20 the conveyor, wherein the candling apparatus is
configured to candle each egg in the stream and to
designate each candled egg as either live, non-live, or
uncertain as to whether live;
an egg removal device operably associated with
25 the conveyor that removes from the stream candled eggs
designated as non-live and uncertain;
a hand candling station wherein each egg
designated as uncertain is hand candled;
an egg transfer device operably associated with
30 the conveyor that returns to the stream eggs observed to
have one or more of the following: red veins, an air cell
at an end of the egg, or a dark embryonic area.

27. The system of Claim 26, wherein the

candling apparatus comprises an apparatus configured to measure the opacity of each egg, wherein an egg is designated as live if measured opacity is less than a first threshold value, wherein an egg is designated as 5 non-live if measured opacity is greater than a second threshold value, and wherein an egg is designated as uncertain if measured opacity is between the first and second values.

10 28. The system of Claim 27, wherein the candling apparatus comprises:
 a light source that illuminates each egg with light; and
 a detector positioned adjacent each egg that 15 receives light passing through each egg.

20 29. The system of Claim 26, wherein the candling apparatus comprises an apparatus configured to measure the temperature of each egg, wherein an egg is designated as live if measured temperature is above a first threshold temperature, wherein an egg is designated as non-live if measured temperature is lower than a second threshold temperature, and wherein an egg is designated as uncertain if measured temperature is 25 between the first and second temperatures.

30 30. A system that rapidly and accurately identifies live eggs within a stream of eggs, comprising:
 a conveyor configured to convey a stream of eggs;
 a candling apparatus configured to candle each egg in the stream and to designate each candled egg as either live, non-live, or uncertain as to whether live; 30
 an egg removal device operably associated with

the conveyor that removes from the stream eggs designated as non-live and uncertain;

a spectrum generation and analysis apparatus,
comprising:

5 a light source that illuminates uncertain eggs with light in both visible and infrared wavelengths;

10 a spectrometer that receives light passing through each uncertain egg, wherein the spectrometer obtains intensity values of the received light at selected ones of the visible and infrared wavelengths, converts light intensity values into a spectrum, and compares the spectrum with a spectrum associated with a live egg; and

15 an egg transfer device operably associated with the conveyor that returns to the stream uncertain eggs determined to have a spectrum that substantially matches the spectrum associated with a live egg.